DOCUMENT RESUME

ED 167 173 IR 007 018

AUTHOR Ducker, W. Marc
TITLE Non-Print Media Storage, Retrieval and Display--Systems for Libraries and Education.
PUB DATE 77
NOTE 55p.

EDRS PRICE MF-$0.83 HC-$3.50 Plus Postage.
DESCRIPTORS Academic Libraries; *Audiovisual Aids; Broadcast Television; Computer Science; *Educational Development; Educational Television; *Information Systems; Library Services; *Media Technology; Microforms; Public Libraries; Radio Technology

ABSTRACT

This paper presents a summary of the current state of the art in nonprint information systems, as well as an overview of potential developments with emphasis on educational applications. While most libraries and educational institutions today have become somewhat nonprint oriented, there are wide differences in utilization among institutions. Examination of simple delivery systems, such as traditional library loan and radio and television broadcasting, indicate the potential to become more user-responsive. Specialized delivery systems (communications media) play as much of a role in shaping complex information systems as their storage, retrieval, and control devices. It is only with the advent and spread of narrowcasting wired systems, and computer and satellite data transmission that some of the more complex information systems have become viable. Present nonprint information storage and retrieval systems, including microform and nonprint libraries and data banks, have various applications calling for different combinations of systems. Anticipated technological advancements for these systems indicate a broad potential for educational applications. A timetable of predictions for future development is included. Author/CWM)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED167173

NOV 20 1978

U S DEPARTMENT OF HEALTH,
EDUCATION & WELFARE
NATIONAL INSTITUTE OF
EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY

NON-PRINT MEDIA STORAGE, RETRIEVAL AND DISPLAY--
SYSTEMS FOR LIBRARIES AND EDUCATION

BY

W. MARC DUCKER

MEDIA LIBRARIAN

LAGUARDIA COMMUNITY COLLEGE

LONG ISLAND CITY, NEW YORK

COPYRIGHT 1977

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

W. Marc Ducker

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC) AND USERS OF THE ERIC SYSTEM."

IR007018

ABSTRACT

A summary of the current state of the art in non-print information systems is given, along with an overview of potential developments. Particular attention is given to educational applications. Both simple delivery systems (library loan, broadcast television) and complex systems (computerized, dedicated networks) are discussed in terms of existing and anticipated technologies, with current and hypothetical examples described. A chart containing a timetable of predictions for future development is included.

CONTENTS

INTRODUCTION 1

PRESENT SYSTEMS 3

I Simple Delivery Systems 4

A. Loan 4

B. Broadcasting 7

II Complex Delivery Systems 10

A. Narrowcasting 10

B. Wired Systems 11

III Present Information Storage and Retrieval Systems 25

A. Microform 25

B. Libraries and Data Banks 27

C. Educational Applications 33

THE FUTURE 38

I Technological Advancement 39

A. Transmission 39

B. Storage and Retrieval 40

C. Computer and Display Technology 41

II Implementation Projections 43

Chart: Future Growth of Non-Print Technology, Timetable of Projections 45

NOTES 46

INTRODUCTION

This paper is intended to be a summary and overview of the current state of the art and of possible future developments in equipment and small- and large-scale systems used to deliver nonprint media materials. These materials include audio, video, visuals, microform, and programmed and computer-assisted instruction and complementary bibliographic software.

In the course of research, some extreme conflicts between dire and pie-in-the-sky viewpoints were encountered concerning the potential growth of these systems.

It appears likely that the discrepencies encounted were due to the same two problems that seem to have historically plagued information and communications planning. The first is the inability to keep up with scientific and technological advances. (Entire projects, such as EVR, get shelved midstream in their implementation.) The second is the failure to predict and control the economic and political variabilities of society. (Opportunities go begging because, as in the case of videodiscs and pay TV, corporations are allowed to play it too safe by friendly government regulators.)

In the course of this paper, the current and anticipated systems and some of their peripheral benefits will be mentioned. The order of presentation is somewhat arbitrary because of the many interrelationships between items but, generally, the material proceeds from the smallest and most proven systems to the largest and most hypothetical.

No attempt is made here to cover every project or every opinion, to describe systems technically, or to be bibliographically com-

prehensive. But this overview attempts to present the reasons for an increased optimism that we will soon see the development of large-scale non-print library and education systems and consequent alarm over the lack of a strong and systematic national program of planning and guidance.

PRESENT SYSTEMS

While most libraries and educational institutions today have become somewhat non-print oriented, there are wide differences in utilization among institutions. The basic variables discussed in the literature on this subject are:

1. Whether the institution's information lends itself to or demands non-print coverage (e.g., art library--slides; medical library--processes and techniques; engineering school--mathematical functions and scientific modeling).
2. The size and newness of the institution itself. For example, recent elementary school libraries have already been transformed into "media centers," while to some extent high school libraries and community college libraries and, to a greater extent, academic libraries, lag behind in the newer instructional modes.[1,2] More recently built institutions at all levels are typically more responsive to media and fint it easier to incorporate them.[3]
3. Parameters of access such as distance, scattered population, or infirmity that make traditional classroom teaching and library visits inconvenient inspire the development of new technological solutions.
4. Prospective user problems (inexperience, lack of information, or previous difficulties) may cause a reluctance to incorporate or even consider such materials.

It is hard to make further generalizations because of the wide variety of data. Although the economic crunch of the 70s and other factors have, in some cases, prevented full implementation of some promising programs, some of these cutbacks have enabled a general tightening of loose ends and a weeding of ineffective programs. Also, despite the economy, some new ventures are making significant progress.

I SIMPLE DELIVERY SYSTEMS

A. Loan

The most basic system of information storage and retrieval of non-print media is the traditional library approach of in-house circulation and library and interlibrary loan. Often, however, as Deirdre Boyle points out in the centennial issue of Library Journal, we find a condition has developed where free access to non-print media is limited because an institution fears damage of materials and equipment, or simply (and perhaps hypocritically) does not provide adequate means of access and display.[4] This is quite prevalent in public libraries and universities where, for example, films may be available for public showing and classroom use, but not offered to individuals or students. On the other hand, at least one library has gone so far as to lend videotape recorders for home use.[5]

One can take video as a prime subject for an analytic discussion of the variables involved in loans. The advent of home videocassette and videorecord (disc) playback equipment will soon change existing access patterns drastically if it makes video equipment as prevalent as audio now is in the home. (It is expected that a 30-minute videodisc will cost about the same as an lp record.) Increased provision of video software by libraries would then be warranted. As in all media, several other factors would be involved in loan facilitation.

1. Availability of software. The Phillips/MCA system plans on an initial software selection primarily consisting of current films, while RCA's system is preparing a wider menu of software, including how-to-do-its and shows. The type of software available will in-

fluence the growth of institutional collections, and the producers may actually try to discourage the loaning of materials to increase sales.

2. Uses. The virtually indestructable nature of the Phillips plastic-coated disc could make it an ideal circulation vehicle for all types of publishable audio and visual software (including eventually print, if Phillips does not abstain from offering the option of single-frame recall). The lack of local recording ability on discs will make videotape continue to be of value to educational institutions and local producers.

3. Access. Many libraries have still not made the transition to integrated catalogs, and this leads to underutilization of materials. Nor have adequate national and regional cataloging and loan setups for libraries been developed. Efforts in this direction include the Great Plains National Television Library and the New York State and the Rocky Mountain State Regional loan systems, but costs and waiting time are still burdens. Others include the Ontario Educational Communications Authority (OECA), and our new Public Television Library, which, as a national depository for public television programs:

> could more appropriately become a national public telecommunications center, housing a wide variety of audiovisual materials in forms compatible with the newer technologies. It would provide a valuable information resource for the nation and, as a clearinghouse, would help to eliminate the duplication of effort that now takes place in the production of public broadcasting programs.[6]

(The Public Television Library has already started an experimental cassette-access program in a number of libraries.[7])

The present need for increased access is pointed out by OECA's chairperson, Thomas R. Ide, who has described several thwarted

regional library attempts at videotape circulation.

> ...the real breakthrough has yet to be made. The major obstacles at present, apart from the need to acquire playback equipment, through loan or purchase, are the lack of titles of sufficient number and diversity, the difficulty in cataloging them, and the complete lack of reliable and detailed information about their content.[8]

The OECA is now developing a "videotape programme service" (VIPS) to service schools and libraries. To date it includes 10,000 programs, 4,000 of which have been cleared for distribution, which occurs either by mail or over Channel 19 at $3 per dub. OECA's objective is to have 50,000 titles by 1980, which it hopes will be an adequate number for a home distribution system. In this country, programs of such close cooperation have been on the smaller scale of the Enoch Pratt Free Library's relationship with the Maryland Center for Public Broadcasting in Baltimore.[9] Distribution and cataloging developments will be more fully discussed later in this paper.

4. Circulation. There are problems involving the loan of discs or tapes other than the technical ones listed above. First, the loan of media materials, as with books, denies their availability to others during the time of the loan. This disadvantage can be surmounted for tapes through the use of high-speed duplication directly onto a user-owned tape. This also prevents wear and tear or defacement of the original item, but surprisingly, it is not a common practice. This is partially due to a second circulation problem--that of copyright infringement. While very important for commercial materials, for purely educational, copyright-free material, or for limited ("fair") use (a la print reprography), copyright should not present a major problem. But it is clear that with the advent of major automated systems, a new copyright-fee approach for library

and educational use will be developed and implemented.

B. Broadcasting

Educational or informational radio and television programming is about as old as broadcast media itself. Broadcasting still finds it difficult to accept new applications but improved techniques and technology have continued to surface. It is generally accepted that broadcast can adequately supplant straight face-to-face lecturing, and is superior in some respects in presenting pictorial, audio, spacial, and motion information. Broadcast and narrowcast areas will be covered in some depth in this paper because of their latent potential for delivering software.

There is a scarcity of channels in the standard (VHF) broadcast range; educational and informational channels must therefore appeal only to large-size audiences. Specialized UHF channels, recently nurtured by the Federal Communications Commission, have seen steady growth during the 60s and 70s, and it is projected that this growth will continue at least until 1980, when competition from cable may become intense. The major drawback of VHF/UHF programming is inherent in the word broadcasting: it unselectively (to a broad audience) provides material uncontrolled by the viewer as to time and specific content, and allows for little or no targeting of specific viewers. And even UHF is prohibitively expensive.

The lack of time control can now be easily circumvented by off-the-air recording, but the copyright law's two-week use limitation on the tape can be a major problem. Additional use of dead-air time for individual retrieval broadcast requests could make the system more flexible, but documentation has not been found of this procedure. Most broadcast stations are not at all geared for indi-

vidually targeted broadcasting--Ottawa's Channel 19 (see above) is the rare exception.

Successful large-scale educational broadcasting projects of note are:

1. Japan's NHK Gakuen--approximately 17,000 high school technical students; one program per week per course with special coordinate texts, university-level course being planned.
2. Chicago TV College--approximately 10,000 two-year college students, 600 full time; multiple programs per course per week with optional correspondence and on-campus study (proved equal or better than on-campus instruction).
3. British Open University--25,000 students/growing to 40,000; specially constructed basic B.A. curricula utilizing much written and non-print correspondence and self-study; one radio and one TV program per week; cost equals that of a 5,000-resident student university.[10]
4. Australian Radio Correspondence School and School of the Air--mostly remote-area elementary-school instruction, coordinated with state correspondence courses. "Flying doctors provide two-way radio service."
5. The ubiquitous Sunrise Semester.

With the exception of the first and last projects, all allow for some on-campus experience each year. Tapes are also made available to other schools. James Gibbons stresses that these projects succeed because they are geared to specific target audiences, provide for some sort of on-going interaction and evaluation, and are non-print-based only 5 to 20% of the time. He thus raises serious doubts as to whether access to non-print media via broadcast is by itself a boon to educational cost-effectiveness. On the other

hand, he does not discuss applications of advanced cataloging, computer instruction, and storage and retrieval techniques.

Broadcasting has the potential to become more user-responsive, appeal more to specialized interests, and achieve interaction, as in the OECA project VIPS. Increased numbers of channels and provision of telephone-type response systems might eventually transform even commercial broadcasters into home information-delivery specialists.

II COMPLEX DELIVERY SYSTEMS

Specialized delivery systems (communications media) play as much of a role in shaping complex information systems as their storage, retrieval, and control devices. Indeed, it is only with the advent and spread of these systems that some of the more complex information systems become viable.

A. Narrowcasting

Its importance stems from its ability to transmit information from point to specific point.

1. Instructional Television Fixed Services (ITFS). Sometimes a broadcast medium, but since its 1963 inception, the FCC designated its prime use as being in conjunction with interactive point-to-point ITFS FM response stations, which can now be time-shared. ITFS can also be narrowcast video point to point. Significantly, costs may only be 10% of that of a VHF/UHF station.

A good example is Stanford University's four-channel ITV network, which simultaneously hooks into FM response lines from twenty-seven organizations as far as 40 miles away, thereby halving the total costs of using equivalent telephone response lines.[11]

2. Microwave. It, too, has omnidirectional uses but is primarily point to point. A prime example of both uses is Southern Methodist University's ten-year-old undergraduate and graduate level live-video with interactive-audio system, which utilizes four channels going to seventy off-campus classrooms and a daily courier drop-off of papers. A pre-recession prediction:

> The possibility of using excess channel capacity to provide access to a central computer from the remote TV receiving locations introduces a significant new dimension into the potential usefulness of the system....By the end of the 1970s almost every major institution of higher education in the United States will be

linked with other teaching institutions and with a surrounding community of scholars by live interactive television. Furthermore, a significant number of such systems will be statewide, not just local area line-of-sight ITV systems.[12] (Proceedings of the IEEE, June 1971)

B. Wired Systems

The following four delivery systems are all well established in common carrier-type use, but they are in far more flux than the airwaves because they have not, until recently, been specially designed with non-print media programming or storage and retrieval in mind. Yet here is where their greatest growth potential may lie.

1. Broadband-Cable/Community-Antenna Television (CATV). There has undoubtedly been more written in the last ten years about the processes, potentials, and politics of cable than about any other system. Because pay TV directly threatens theater-owners and networks (there are broadcast pay TV systems also), and because broadcasters of all size fear cable's potential for widening user access to a larger number of stations and types of programming (though it seems, realistically, that only the smallest markets have much to fear), cable has been quite stringently regulated. Nonetheless, basic cable is now growing at a fast rate (30 million homes may have hookups by 1980 as compared with 5 million in 1972).[13]

Although cable's original purpose was simply to deliver distant radio and television signals to remote areas (older systems are usually only able to carry a few television channels), cable's potential for increased channel capacity has been seized upon by community and communications leaders as a valuable resource for home delivery of specialized "dedicated" channels of information and user-controlled "interactive" systems.

Michael Molenda, in the Yale Review of Law and Social Action, claims

that such an increase in specialized channel capacity will cause the major networks to go the way of the once-popular mass-circulation magazines.[14]

One cable expert depicted from 100 to 400 channel availability by 1990 via low-cost amplifiers.[15]

New urban and suburban areas are being mandated in local franchises to provide for increased channel capacities, and the FCC now insists they have some built-in two-way interactive capacity. The advanced new system in Akron, Ohio, for example, is being built with 64-channel capacity, 50% of which is planned for nonbroadcast television services.[16] But the FCC, with a "wait-and-see" attitude, had been requiring only 20 channels (in sizable systems)--including one five-year experimental channel for education and government and a second public access channel with extremely limited free production facilities. It also allows for conglomerate control of many local cable stations, which may bring down costs and increase networking ability but will not help achieve local programming or specialized services.

One area where the FCC regulations are strong (to protect established interests) is in the area of pay TV. However, promising systems have begun to be implemented. Gridtronics of Television Communications Corporation (TVC), for example, is developing a 4-channel pay system for uninterrupted films, instructional programs, information, and special professional medical programming, to be distributed to 70,000 locations in ten states. As in most pay systems, a special device unscrambles coded signals at the receiving end.[17] In systems such as this, programming can be sold on a blanket per-channel basis or, using an interactive system, viewers can indicate and be credited for only the specific programs they

see via narrower-band signals going back to the computer at the transmitting head-end. Theata Cable (TelePrompter Corp.) in El Sequndo, California, and Orange (City) Cablevision in Florida have in progress experiments delivering, in addition to pay TV, merchandising and credit card verifying, automatic security systems (burglar, fire, and emergency), surveys and polls, and special educational or business data services. In Irving, Texas, is a promising experiment where free basic cable services are given out, because there is no market for just conventional service. A $9 fee is charged for two-way service.[18]

Indi idual local franchise agreements can even mandate multichannel facilities where the local library or college supervises operations; non-interactive examples of this occur in the Tulsa, Oklahoma, Boulder, Colorado, and San Jose, California, public libraries where, in addition to public relations, story time, and book reviews broadcast over the public channels, local collections of videotapes are being created by purchases and local productions. The Port Washington (New York) Public Library already has developed a large library of local productions and is now trying to get a "head-end" so it can finally disseminate them. And the Natrona County, Wyoming, and Mobile, Alabama, public libraries have seventy or more hours weekly of direct home reference service.[19] One just calls the library on the telephone, asks for a specific document (or information), and tunes in to the appropriate cable channel. While anyone getting cable can see the information on the screen, privacy is maintained because the questioner remains anonymous. The Natrona (Wy.) Library is already experimenting with plans to tie their school district's computer, their in-house microfilm retrieval

system, and the county's record system into the cable to provide a high-speed delivery system.[20]

The most significant plan for interactive services comes from the MITRE Corporation in Washington, D.C. Through a grant from the Markle Foundation, it produced a development plan and a cost study for the Washington, D.C., area that synthesizes most of the features of other interactive networks. MITRE's "TICCIT" system utilizes two 30-channel (the maximum) broadband cables to deliver three options to all users. The first option is a basic one-way service of local and "imported" off-the-air signals, continuous news, time, and weather, FM, special movies and sports, and municipal, public, instructional, health, special interest, and pay channels. Estimated cost is $2.50 per month plus the basic initial $10.00 installation fee. For an additional $3.00 per month, one receives subscriber-response services such as interactive entertainment and education, utility and maintenance services like meter reading (with a separate fee for each), plus the other services offered by Theta Cable and Orange (see above). TICCIT's third option, the most exciting one from the standpoint of information systems, costs an additional $15.50 to $8.50, depending on whether from 20 to 60% of subscribers buy it. (The price includes the cost of leasing the equipment.) This option supplies "Electronic Information-Handling Services," including computer-aided instruction, interactive entertainment, social services, video library, individualized shopping and reservations, banking and credit, and public information services. The equipment would include a full or partial keyboard, a refresh memory capable of storing still images from the computer (which can handle 600 simultaneous requests

per channel), and a scrambler for individual privacy. TICCIT's private address-gating system (or an alternate universal terminal) would enable mail delivery, credit and bank checks, and individual "Premium TV" program access and billing. The system could provide total service to the anticipated (50%) demand level in the city by the fifth year of operation.[21] An estimated average cost for specialized service time is $ .25 per hour.[22]

Interestingly, in TICCIT, "the total cost of interactive-television--...not including the cost of programming--is very similar to that of the telephone." The concept of the cable becoming a utility on the scope of the telephone system is not far-fetched, though there is considerable economic reluctance and resistance to the enormous capital outlay and supercession of other systems that would be necessary. But the rationale is there. The CATV Operator's Handbook estimated in 1967 that 40% of the nation's mail (business-type) could be much more efficiently carried over a national network of approximately 1,500 local cable systems and 200 regional microwave satellite-connected switching centers.[23] And a 1973 estimate by the commercially sponsored Cable Television Information Center (CTIC) for a complete interactive home system with printout function is from $400 to $500.[24]

Nicholas Henry more or less corroborates these estimates in Copyright, Information Technology, Public Policy, referring to Parker and Dunn's (Stanford University, 1971?) figures of $500 to $700 per subscriber:

> This is the rough equivalent of the capital investment for the current telephone plant in the United States. Annual operation costs of the information utility also would be parallel to those of the present telephone system, which is about $130 per telephone. Parker and Dunn argue that most U.S. homes could have an informa-

tion utility by 1985, if policy research, experimentation, and private development were encouraged adequately at the federal level.[25]

2. Telephone systems.

(a.) Audio. The simpler telephone systems now in use in information-delivery systems utilize the common dial-in random access (or, occasionally, continuously dedicated) lines for a variety of services. Some excellent examples of other services aside from the common and very useful dial-your-local-reference-librarian (exemplified by the New York Public Library Reference Service) are:

--The Minnesota Interlibrary Telecommunications Exchange (MINITEX) centered at the University of Minnesota, which serves over 140 libraries statewide with a complete on-line telephone and teletype reference service, utilizing a daily courier service for the delivery of materials, and weekly teleconference calls among librarians to discuss problems, unify approaches, and centralize services.[26]

--Dial-access (dial-a-tape) systems. Numerous popular services for the medical community and its public are described in an article by Carl M. Pearson. They usually are administered by a clerk, but there is an automated one in San Bernadino County, California, in which each tape has a separate phone number.[27] Further automation is also possible.

--A library of over 2,600 television programs in Ottawa, Canada, which is reached via a phone call and provides a distribution service to four school systems over a special 12-channel cable system. Plans were to expand this with an automated advance-booking system; and to enlarge the service area, possible via time-sharing with other distribution services that are underutilized during the school day (i.e., entertainment CATV channels).[28]

(b.) Video. Essentially, the video telephone can offer a package of services very similar to interactive cable. (Excellent coverage is given by Edward M. Dickson, in association with Raymond Bowers, in his book The Video Telephone: Impact of a New Era in Telecommunications, from which the following information was gathered.[29]) The two significant differences between the video telephone and the interactive cable are the telephone's unique ability to give complete two-way point-to-point video service (which cable cannot feasibly do in mass systems) and its much higher cost (due to the need for an extensive complete phone switching network). Third-world countries developing fresh systems from scratch in the 1980s and 1990s are likely to combine their cable and telephone video services into one efficient, economical system--but the existing situation in the developed countries is for now complex, and calls for strong on-going national planning and guidance.

The only video currently usable throughout the U.S. telephone system is slow-scan, which can transmit broadcast-quality graphic materials and freeze-frames over standard audio lines. Used on dial-up or dedicated lines in optional conjunction with an additional audio line, it offers voice interaction with 55-second delay between still images displayed on the cathode receiver tube, with additional time needed for an optional hard copy to be made. RCA's Vistavoice® version rents for $225 per month, with an additional $125 per month charge for the facsimile hard-copier. Colorado Video offers a similar (but incompatible) system that offers accelerated transmission time by using higher quality leased or local lines.

Since 1968, the Bell System's Picturephone® provides regular (motion) video for a smaller equipment fee, actually, than the RCA system (approximately $150 per month), but it has severe limitations

that thus far have limited its use to a few local experimental areas (e.g., Chicago and Pittsburgh). The hardware of the system is itself convenient to use, and can carry two-way person-to-person live conference calls and graphics. Visual resolution, however, is much less than that of broadcast video, and hence it cannot adequately convey an entire 8 x 11½" typewritten sheet. The system requires special "conditioning" and switching mechanisms on the established audio telephone lines it travels along, and the already narrowed 1M Hz bandwidth of the video signal, even after reduction by digital conversion, now displaces 96 audio lines, making video time very expensive. Bell Research scientists expect to soon bring this figure down to 24 and later to 3, utilizing digital bandwidth compression techniques, but technological advances in bit storage have still not allowed this process to become economical. (Fiber optics may eventually make this search for bandwidth space superfluous--see p.39.)

A flexible videotelephone developed in Sweden by the L.M. Ericsson Company allows for in-house broadcast-quality cable transmission, Picturephone[R]-quality 1M Hz long-distance transmission, and, in addition, high-quality slow-scan video over audio lines.

Along these lines, Dickson and Bowers envision the availability of "super video television" somewhere between 1978 and 1983, with "societal impacts...readily discernible before 1990." The system would include these options: color video of current Picturephone[R] resolution standards; higher resolution, 4-second slow-scan; high-speed paper copy halftone printout; connected video recording unit capable of taping motion or very high-speed (perhaps thirty pages per second) transmissions of slow scan; full alphanumeric electronic

keyboard and character generator for direct display and computer interaction; "call waiting" alert signal: hands-free voice operation (presently available); and boldface typewriter types for accurate transmission of prepared materials! This system would cost about the same as today's Picturephone[R] and be available primarily for business-community use. Estimated cost for national, local, and long-distance video service for 1984 (utilizing an admittedly optimistic projection of two million video telephones in operation--1% of the country's total phones in 1984) is average capital investment of $10,000 per subscriber and total system estimate of $20 billion. Such capitalization, the authors point out, is unlikely. (The entire Interstate Highway System costs $70 billion.) The CATV industry, in contrast, is hoping for a $1 billion per year investment.

In another section, these authors indicate:

> Parker and Dunn estimate that a two-way CATV system [a la TICCIT] in a medium density urban location might require an investment in plant of about $620 per subscriber including $100 for a television set...about a factor of 7 less than the $4400 estimated...for a Picturephone network restricted to local service.[30]

Dickson and Bowers suggest important uses for the video telephone (some of which overlap those of interactive cable): elimination of travel for business conferences and other unnecessary or difficult trips; consequent savings of energy (surprisingly, their figures show that the video telephone is much more expensive in dollars than travel for conferences of an hour or more); consultations by physicians and medical paraprofessionals (to remote areas and specialists); access to medical records and automated centralized medical archives; educational programs; personal telecommunications for the deaf; new programs and services in areas such as emergency

counseling, talk shows, town meetings, interstate adoptions, lost and founds, real estate shopping, and job interviews; access to computer information, interactive education, emergency data base, computation, and composition services; remote surveillance of medical cases and danger situations; rapid telefacsimile and file transferral; and library networks and pooled resources. The authors argue that the professional features unique to video telephone "are superfluous for most applications of interactive video envisioned for home use,"[31] but seem to be negligent in naming services of the video telephone more economically and probably equally as well performed by interactive CATV. It is clear, though, that the video telephone is a workable system with singular functions and, as Louis Vagianos corroborated in a 1976 state of the art article in Library Journal, "progress in integrated electronics, imaging devices, and band compression techniques, will make it a practical item within the next decade."[32]

3. Facsimile Communication ("fax"). More a related peripheral system than a carrier itself, facsimile networks have a history of utilizing configurations of dedicated networks (of the previously described wired systems) that warrants its being placed within this area of the paper.

"Fax" has a long history of applications: from its early mechanical developments as competitor to the telegraph, to its fruition in picture transmission systems for newspapers both by wire and intercontinental radio in the 20s, and its use by the weather services and Western Union beginning in the 30s and 40s. The 1940s saw a strong but vain effort to compete with television via FM broadcast home

newspaper fax systems. Recently, significant developments have included the continued improvement of special AT&T lines, automated wet and completely dry (direct) recording processes, inexpensive telephone-coupled transceivers for lease (Magnafax[R] by Magnavox) or sale (Telecopier[R] by Xerox), and bandwidth suppression speed-doubling. Fax can now be hooked up to microwave; depending on reproduction quality can reduce processing time from the normal 6 minutes to a few seconds; can be mobilized for police use of data banks of mug shots; and can be used for high definition fingerprint and microfilm transfers. "There are now over 50,000 terminals in the USA and the growth between 1970 and 1971 was reputedly 500 percent."[33]

Item: In the past, experiments in library use of telefacsimile systems for transfer of document copies have not been found to be justifiable for a combination of reasons (economics and speed). The one successful system (at Penn State) is utilized for distribution of instructional materials to remote campuses.

Item: An encouraging library developmental project at M.I.T.--Project INTREX--is now utilizing revolutionary high-speed facsimile microfilm input and output transfer in conjunction with automated storage and retrieval.

Item: The fastest telefacsimile system is still the 1940s RCA Ultrafax[R] which, utilizing special TV channels, achieves 480 pages per minute.

Item: Matsushita of Japan makes COLORFAX, distributed in this country by Litton. The Japanese have now begun a new generation of home fax newspaper recorders. (Toshiba's AT3 markets for about $100 in Japan.)

Item: Broadband systems now can permit speeds of up to only 6 seconds per copy. Also, RCA, Phillips, and Matsushita have all developed systems of piggybacking fax signals on commercial TV blanking pulses. A 1971 forecast made for 1985 was for fax distribution of mail, library books, newspapers and magazines, and other information to homes at costs comparable to 1970 postage rates and at speeds of 1 second a page for black and white and 3 seconds a page for color![34] Machines would be the size of attache cases or smaller, and if hooked up to video telephone lines, would make copies even faster (the existing RCA Videovoice slow-scan copier makes black-and-white copies in 10 seconds).[35]

Item: Britain already has a pilot computer-fed home system operational and is beginning implementation (CEEFAX).[36]

C. Computer and Satellite Data Transmission

The advanced cable systems, video telephone systems, and telefacsimile systems all now utilize computer technology in their communications networks and planning. (Quadrophonic FM radio makes use of related computerized digital encoding.)

1. Digital data transmission. The conversion (encoding) of complex analog waveforms into digital binary signal pulses or bits (analysing samples of the signal) is called "pulse code modulation" (PCM). Utilizing PCM in trunk route switching centers eliminates many problems of noise, electrical interference, and crosstalk, and allows frequency or time division multiplexing (FDM/TDM) to vastly increase the message capacity of a transmission line. In the case of the Picturephone[R] system, differential pulse code modulation (DPCM) is also performed, yielding redundancy and, hense, compression of signal.

Item: Digital transmission is now also applied to both telefacsimile communication systems and interactive cable systems. Common carrier costs are now beginning to drop rapidly as a result of these systems, though initial costs still are quite high.

Item: Despite enormous data-carrying capacity in each line (a single bank line can handle 240,000 transactions a day), AT&T's fastest-growing service is dedicated, leased, data transmission lines.... Because of the tremendous growth of computer industries, specialized microwave common carriers are beginning to offer AT&T direct competition. Volume inherent in the previous 1985 projection of 2 million Picturephones[R] combined with 6 million other computer data terminals could then bring long-distance audio phone rates down to local phone levels!

Item: Data transmission "busy signals" are being slowly eliminated by a new generation of electronic switching exchanges that eliminate all electro-mechanical breakers by providing computer short-term packet storage.[37]

2. Digital read-in, read-out, and display.

Item: Digital signals can also be used for alphanumeric and binary representations of texts (and now even of pictorial and video information). Importantly, digital information can be stored in advanced, solid state random-access computer memory banks, which are an increasingly fast and cheap improvement over the old magnetic tapes for short-term applications. Pure digital transmission of alphanumeric data is much faster and cheaper than the equivalent using "fax."

Item: Cathode Ray Tubes (CRTs) in both video telephone and interactive

cable can have alphanumeric read-outs of about 400 characters, an improvement over earlier systems.

Item: New Optical Character Recognition (OCR) techniques allow limited direct input/output of original print materials and even graphics (some), but equipment costs are still high and thus now feasible only for large-scale operations.

3. Satellites. Fixed communications satellites are a limited supply item. The sky has almost filled all its available locations for these transferrers of wide- and narrowband communications, yet there is still much opportunity for expanded usage with existing installations, in both microwave and radio and television broadcasting.

> Looking into the communications future of the 1980's one can visualize satellites broadcasting directly to libraries, businesses, and even individual homes.... NASA has contracted with Fairchild Industries for the development of the ATS (Applications Technology Satellite)...[and we foresee] widespread use of this advanced technology well into the 80's.[38]

Item: ATS Satellites have transmitted basic educational TV programs to approximately 1,500 receivers in Alaska, the Rocky Mountains, Appalachia, and India.

Item: The Satellite Library Information Network is scheduled to begin a twelve-state hook-up of digitally compressed bibliographic data.[39]

III PRESENT NON-PRINT INFORMATION STORAGE AND RETRIEVAL (IS&R) SYSTEMS

Because different IS&R systems have different applications calling for different combinations of systems, the following list of projects and devices can be organized only loosely.

A. Microform

Microform has growing applications in both bibliographic and document storage and retrieval through viewers, television systems, and cathode ray tubes (CRTs), hard copy printout and, most recently, high-speed duplication and distribution to user terminals (e.g., MIT's Project INTREX). Microform is most important as space and speed saver for storage and mailing purposes, as inexpensive form of publishing, and as means of preserving perishable materials.

Item: Current objections to ease of use are being overcome with the development of $50 book-size microfiche "lap readers" (DASA Corporation).

Item: There is currently no large-scale distributing microfilm service for pictures, slides, photographs, or their indexes (and color microfilm is still not in popular use), though this is technically feasible. Successful models for black-and-white systems exist, however, in both commercial and nonprofit print systems. Examples include:

--Indian Head's Visual Search Microfilm File (VSMF), which markets by mail regular updates on fiche and film of various lists of military and industrial specifications, product descriptions, and manufacturer's catalogs.

--The Educational Resources Information Center (ERIC), through which the U.S. Office of Education processes, weeds, and indexes

reports and periodicals, and compiles related indexes, abstracts, and single copies on fiche (about 20,000 items a year).

--Regional services such as MINITEX, which compiles MULS (Minnesota Union List of Serials) on microfiche.[40]

--Libraries are the target of microform publications and reprints by University Microfilms and also numerous indexes. Entire libraries of material are reproduced on "ultrafiche" (50-90x reduction), notable Encyclopedia Britannica's $22,000 Library of American Civilization, which includes a detailed and descriptive index.[41]

--Blackwell of North America, a major wholesale distributor, provides an up-to-date catalog via the new computer output microform (COM) to its customers.

Item: Microform retrieval systems include:

--Simple systems utilizing fiche on keypunched aperture cards and Microseal Corporation jacket cards.

--Advanced 16mm film cartridges requiring more expensive readers: Kodak's 16mm Miracode, which utilizes photo-optic binary coded film, provides second-long search and retrieval and hard-copy printout. It is used by the Army Photo Agency, the Broadcast Pioneers Library, and the NBC Film Library at cost of about $35,000. The Kodak/3M Microdisc features completely integrated random access via minicomputer without presplicing and filing; CRT input/output; and a high-quality 3M Page Searcher continuous-tone dry silver reader printer; and costs $70,000. Both Kodak systems allow for the complex descriptors and multiple-search criteria so important for large applications. Higher-quality 35mm cartridge rolls, with odometer retrieval, are also sometimes used.[42]

Item: Xerox has developed an automatic sequential microfiche printer for the National Technical Information Service (NTIS)[43]; and Itek makes a super high-quality stabilized silver printer for halftone and continuous tone illustrations. (Good, easy-to-use planetary cameras are available for $1,000 to $2,000.)

Item: The New York Times, in connection with its new Information Data Bank computer index/abstract service (CRT and printout), has developed a prototype automated microfiche retrieval system via video display for the documents and articles themselves. It is now only in limited in-house operation but is planned for an eventual mass distribution network. "If this works out, the Times will have offered the first general information system in America."[44]

Item:

> It is now possible to photocopy all the earth's recorded information (approximately 20 million volumes) with an optical-microscope; and to reduce its bulk to twenty volumes that would total 10,000 micro-pages; this would be the equivalent of a set of encyclopedias. A home-based, desk-top universal library that flashed desired information on the homeowner's television screen, and which served at least 200,000 clients, probably would sell for from $3,000 to $6,000, including copyright costs.[45]

Item: MCA's videodisc, if equipped with single-frame stop capacity with automatic indexing, will have the capacity for storing 54,000 complete images per 4" 30-minute track. At least for distribution purposes, this makes it a likely successor to microfilm for some systems.[46]

B. Non-print Libraries and Data Banks

The absence of documentation of the efforts in the planning and development of centralized non-print indexing and storage systems is striking. While the technology advances, national systems development and implementation has lagged. However, recent indications are more positive.

> Essentially...the state of the technology far exceeds our ability to utilize it. If there is a major problem, at present, with [information storage and retrieval] systems, it is in the development of software. To discover a data bank, an information collection, or a potential application is one thing. To develop an information system out of it is another.[47]

1. Existing collections. There are a number of picture, film, and broadcasting archives and special non-print libraries now operating quite separately from each other; and by and large they are not yet automated. Their holdings would be extremely valuable for national archival cataloging and/or interconnected storage and retrieval systems. Then, along with increased use of CATV channel capacity, videodisc publishing, etc., these resources could fulfill needs among students, scholars, and home users for non-print information and instruction.

Item: The much expanded Margaret Herrick Library of the Academy of Motion Picture Arts and Sciences in Beverly Hills, California, holds over 9,000 books, many periodicals, three files of clippings and stills (generals, productions, and personalities) covering 40,000 films; a floor full of important archival collections; and also houses the National Film Information Service, which handles research queries and requests and publishes Screen Achievements Records Bulletin covering production credits for this medium with five-year cumulations and bimonthly supplements.[48]

Item: The National Academy of Television Arts and Sciences' NATAS-UCLA Television Library houses an archive of 5,000 mostly commercial programs and adds about 800 each year, recieved on kinescopes, 2" magnetic tape, 16 mm film, and 3/4" cassettes. They provide a detailed published catalog and data sheets, including subject cataloging by genre and form (e.g., variety, musical), and scripts, but the programs are not circulated outside the library.[49]

Item: Vanderbilt University houses the specialized Television News Archives, publishing a detailed subject index and abstract of the network evening news shows and renting individual show tapes and compilations for $15 to $30 per hour.[50] And National Public Radio has begun the process of preserving its broadcasts through the National Archives and Library of Congress.[51]

Item: Significant cataloging developments are occurring with the computerization and standardization of the British National Film Catalogue (BNFC) and the documentation of the holdings of the American Film Institute and the United Kingdom War Museum. In addition, the BNFC has joined with Current Video Abstracts (Amsterdam) to attempt international standardization of descriptions and documentation of terms and procedures for computer tapes and discs.[52]

Item: William S. Paley of CBS has recently opened the Museum of Broadcasting in New York City, which has begun developing a large, varied collection of broadcasts that are computer-cataloged using the Library of Congress MARC format. The materials, unfortunately, do not circulate, nor are they duplicable.[53]

Item: News libraries (at the New York Times, for instance) are finding that conversion to computerized systems has suddenly become cost-effective. EDP cataloging routines have also been applied to record libraries in radio stations.[54] The various British Broadcasting Corporation library services, the largest of their kind in the world (providing information backup for 2,780 hours of programming per week) have begun the enormous task of trying to consolidate their many independent cataloging arrangements and locations of press clippings, books, and pronunciation materials into one computer-based system.[55] And at a recent conference of newspaper librarians, it was forecast that most newspapers with circulations of

100,000 or less would initiate automation via "keystroke and image system technology" and networks would be set up among smaller papers and in regional offices of large papers.[56]

Item: Educational film and television distribution libraries, and the National Television Library, which have already been discussed (pp. 5-6) each publish their own nonstandardized catalog.

2. Bibliographic information. The recent availability of computers has made the absence of centralized cataloging efforts in non-"traditional" (non-print) media more apparent. While the Library of Congress provides a National Union Catalog for its and some other major libraries' non-print holdings, and specialized print catalogs exist for schools (National Information Center for Educational Media Indexes, NICEM), for education (Learning Directory), and for medicine (National Library of Medicine/AVLINE), none of these provide comprehensive, up-to-date bibliographic control even in their own areas. Videotapes in particular are inadequately cataloged. There is a strong need for more thorough subject indexing and descriptive information, especially for noneducational but still informational material.[57]

The new technology has led to the development of specialized classification procedures. The traditional professional subject headings outline and finite thesaurus of descriptors (keywords) may still be necessary for large, multispecialized collections (the New York Times publishes its own subject list of keywords, as does MEDLARS); but increasing success has been found in changing, at least partially, to free-form natural language "non-static" thesauri that can be completely computer-constructed with the help of a clerk. Additional editing may then be done by a professional editor.[58]

Designator categories such as "format," "locally produced material," behavioral objective," and "audience-level" must be professionally chosen and implemented for fullest service to users. (E.g., doctors must increasingly resort to using the cassette-tape format for information updates during car commutation.)[59] Computer printouts can provide individual catalog compilations by designation--thus making access available whether various media materials are on open integrated shelves or in remote separate locations. For abstracts, it is recommended that materials be analyzed weighing both subject content and quality (because of limited coverage in certain areas) and that listings be made as comprehensive as possible, with high-quality materials indicated as such.[60]

Item: An experiment at Columbia University created three computer data banks for foreign languages, reading, and speech education from the holdings of the Art Library.[61]

Item: A most extensive cataloging investigation of film and television programming is taking place in conjunction with the aforementioned (p. 6) Ottawa VIPS service. Using the University of Toronto's facilities and large system simulation techniques,

> it has so far focused on the analysis and description of a programme taken as a whole, as well as on the identification of sequences, which might be used independently. Self-contained sequences have been isolated by indexers according to certain criteria, including unique quality of the presentation.[62]

Twelve categories relate to educational objectives or learning experiences (interaction, relationship, process change, terminology, theories, behavior and aesthetic or provocative expression, etc.) and twenty-seven categories to formats (group presentation, interview, animation, puppetry, music-vocal, poetry, actuality sound, etc.).

Item: Encyclopedia Britannica Films recently has made a computerized catalog that provides a variety of access points to segments in their vast collection of educational motion pictures. The catalog, which is now available in a multivolume printed set, can be used to locate material by subject, location, time period, etc.
Item: Other agencies working in computer cataloging of non-print materials are the French and Swedish national broadcasting systems and the German Institut Für Film und Bild. The goal is international compatibility by 1984.[63] (European national broadcasting companies often have much more extensive active collections of records, films, and tapes than the U.S. because they are centralized services.) New comprehensive indexing systems are legion in the print area. Lockheed Dialog, Systems Development Corporation (SDC), and Bibliographic Retrieval System (BRS) services each feature national networks of on-line interactive retrieval for a total of over twenty specialized indexes in chemistry, psychology, agriculture, business, education, ecology, etc. Each is split about half and half between government and for-profit indexes. They utilize TYMNET intercity satellite service as well as dedicated or leased telephone lines. Costs are now about $30 to $120 per hour for various indexes, $.10 per record printout, $100 per month for a dial-up terminal, $400 to $500 for fast terminal and printer, $300 more for high-speed CRT display, plus $10 to $20 an hour for network time. Searches average 10 to 15 minutes of on-line time.[64,65] Recently, the NICEM (p.28) non-print data base has been made accessible on-line.

C. Educational Applications

1. Networking. As described before, networking facilities already exist that are capable of wide dissemination of programs and information through other than normal broadcast channels. One such proposal in this area is for a "free" national medical information network of 106 educational television stations hooked into 72 AT&T closed-circuit distribution centers (for an estimated cost of $.11 per viewer hour for 85,000 viewers).[66] Already, pharmaceutical companies have supported Community Medical Cable casting (CMC) to doctors over twelve leased eastern CATV stations.[67]

Lincoln Center's (N.Y.C.) proposal for a national cultural pay-channel plans for off-hours' use of existing networks (PBS, TVS, Hughes Sports, etc.), and cheap satellite receivers going from local multiple point distribution services (MDS microwave) or ITFS into local cable systems' home descramblers or an independently owned system. The implementation of the independent system involves a cost to viewers of perhaps $1.50 per hour, which includes a profit used to supply extensive cultural programming. The proposal claims that for economic reasons such a channel will not become available until significant involvement comes from the cultural institutions themselves.[68]

Economic and programming support is being gathered for general educational ventures as well.

Item: The Hughes organization has done a study indicating the feasibility of a commercial cable networking of cultural and general educational programming (theater, crafts, etc.).

Item: H.S. Dordick, of the White House Office of Telecommunications, has a feasibility plan called Edu-Cable for commercial leased channel

ventures in local cable systems of 5,000 or more subscribers utilizing the new home descramble devices. He notes the need for mostly preproduced programming to reduce costs.[69]

2. Programming. Consortiums of colleges in both southern and northern California have formed to produce programming, initially for ETV broadcasts, but like the British Open University programs they should be available for wider distribution. The problem of school resistance to incorporating out-of-house series and the need for the construction of modular, information learning sequences is being fulfilled to some extent at the public school level by the Great Plains and the National Instruction Television (Indiana) ITV centers, and the State University of Nebraska (S-U-N) has expressed intentions "within five years to evolve into a [TV] University of Mid-America."[70]

Because of the still problematic but potentially fast development of cable and ITV systems, the Carnegie Commission on Higher Education (1972) recommended financial support for centralized efforts so that by 1980:

> At least three cooperative learning-technology centers, combining the instructional technology capabilities of many member institutions within a geographic region, and originating and directing centralized instructional services through information, communications, and computing networks, will be in operation.[71]

Molenda has doubts about significant interaction between educators and CATV before 1984 because of franchiser economics and lack of regulatory and funding support. Factors on the plus side are the continued growth of adult and continuing education, which videodisc publishers are already preparing for, and the critical transportation/fuel issue. On the minus side, though, is considerable political reluctance to deal with the status quo in a time of

teacher surpluses and delicate broadcast economics. Moldenda thinks the old "system has enough momentum, if nothing else, to keep it going for at least another generation....[but] ultimately, cable television's greatest effect may be its contribution towards making the schools obsolete."[72] He suggests the federal "edu-credit card" concept of individually chosen instructional packages supplanting public schools as a factor in this eventual restructuring.

While Molenda's words may be a bit extreme, there is good evidence for the feasibility of large-system technological developments:

Item: Hagerstown, Maryland, and American Samoa have developed educational systems with a "backbone" of ETV and, for years, have found them cost-effective.

Item: The Mineola, New York, school district is making pilot plans for building its own CATV system with students working from home-response terminals supplemented by some daily school activity. (The problem many school districts will find is that they overlap the boundaries of more than one established cable company--or vice versa.)

Item: While " a majority of the formal research studies on two-way television instruction have yielded negative findings," one-way instruction has been shown to be effective in lecture situations, and some more advanced interactive projects have had positive outcomes.[73] More importantly, full computer-aided instruction (CAI), when well planned and programmed, is certain to offer many educational benefits. Herman Kahn argues, " from empirical evidence, that computer-based teaching machines do a far better job at developing security and a sense of self-esteem in children than do flesh-and-blood teachers with all their human foibles."[74]

Item: The Ampex Pyramid System, first designed and introduced

in Oak Park River Forest High School in Chicago in 1967, has developed into a completely individualized random access system for programmed instruction and rapid retrieval of audio, video, and print materials. In addition to basic language lab and stereo playback facilities, Pyramid's computer is able to handle requests via sixteen-button touchtone (digitalized) pads or home telephones for multibranch instructional computer programs with interrelated graphic and alphanumberic simulations, problem-solving functions, and fully integrated media. Access to audio and video is through high-speed (22.5 second) transfer of basic modules of 15 minute or less onto buffers or student-handled cassettes. Learner responses can be stored and analysed, and cumulative records of all processes can be derived. In addition, there is teletype printout for test materials, etc., and simple typewriter "conversational" command language for the courseware designer's input. There is also a library archives of supplemental materials and programs for rapid manual insertion.[75] (MITRE's TICCIT system described on page 14 offers strikingly similar features, but is designed for community cable as well as in-house distribution.)

Item: Extensive development of a complex yet high-volume CAI programming system called PLATO IV has been developed at the University of Illinois. It features open-ended, interpretive interaction with students in sophisticated courses such as high-level engineering and science. Learning time can be cut by from one half to two thirds and this form of learning is often preferred by students. It can be made available to specifically constructed remote digital-pictorial plasm display terminals (but not yet audiovisual recordings) 150 miles away at costs of $1,500 to $3,000 per terminal, $.30 to $.50 per learning hour, and a projected $.03 to $.05 per

hour for a higher-volume TV mode.[76]

Item: "R. Louis Bright, former U.S. Associate Commissioner of Education for Research, has predicted that the majority of American elementary schools will have computer-managed instruction by 1978, and that computerized teaching should spread to secondary schools and junior colleges in less than twenty years."[77] Such developments may be encouraged and supplemented at all educational levels by the new small-scale systems use of Large-Scale Integration (LSI) logic circuitry chips (hooked into individual audio tape cassette programs, keyboards, and television receivers) now under development by the Department of Defense.[78]

THE FUTURE

The technological future has frequently been the subject of bold predictions and almost invariably has been mistaken for a new version of the past. The best that can be said for the following concepts is that they are real--founded in current experimental reality; the worst that might happen to these projects could be laissez-faire development of them along the lines of our present trendy commercialized television, or our overequipped, poorly balanced health care/hospital system.

This discussion is divided into two sections, Technological Advancements and Projections for Implementation, followed by a chart presenting a synopsis of some timetables for future patterns of growth. The projections are approximate in that they cannot predict the possibilities of crash development and implementation programs due to political or economic factors (as occurred in the national science education and space programs) or, obversely, slowdowns from severe program cutbacks.

I TECHNOLOGICAL ADVANCEMENTS

A. Transmission

In addition to gradual improvement in miniaturization and economical switching systems, a number of very promising new transmission media are being developed.

1. Fiber optics. These strands of extremely pure optical glass, as thin as human hair, are the most exciting development in the field. Because of the wide frequency range of light rays, they are capable of carrying huge amounts of pulsating signals. Messages are converted onto, and then out of, the glass rods via laser beams with no need for the equalization processes of current copper wire transmission. A 1,200 wire, 4-inch copper cable, weighing 12,000 lbs., will thus be supplanted by a 6-fiber, 1/5-inch flexible cable weighing only 90 lbs. (which in the near future should be able to increase its carrying ability an additional ten times).

John de Butts, Chairman of the Board of AT&T, which is developing fiber optics in conjunction with Corning Glass, says an economic feasibility test was started in 1976; and the Arthur Little Company sees development by 1980 of a billion-dollar world market with first utilization by large buildings, university campuses, etc.[79]

2. Bell Laboratories has also developed a millimeter wave guide piping system that is capable of carrying over 200,000 simultaneous two-way telephone calls over long straight-line hauls, but alignment difficulties in the installation process still need to be overcome. Other possible transmission systems are lensed laser pipes and the futuristic transmission of subatomic, matter-penetrating muon particles (the latter being only slightly more than conjectural at this time).[80]

B. Storage and Retrieval

The usefulness of the videodisc system previously described depends in great part upon standardization and acceptance in the marketplace and the consequent willingness of manufacturers to expand on the potentials of the equipment. (The RCA holographic system, in contrast to MCA, has not been developed with the idea of ever providing single-frame access.) The home video recorders now becoming popular could become vastly more valuable with the advent of the high-speed band and message compression techniques described below.

Item: If MCA or another manufacturer were to provide discs in the already feasible one-hour length, then six inexpensive long-wearing discs could hold 100,000 pages containing six "catalog card" entries per frame, according to R. May Willocks. The entire catalog of a university or other library could then be remotely accessed via an economical storage and retrieval system over cable TV (using six random-access playback machines at an estimated total cost of $4,000). However, "the cost of the original recording would be significant, a price comparable to microfilming the catalog."[86]

Item: The Rapid Transmission and Storage System (RTS), developed by Peter Goldmark, the inventor of LP discs and EVR, is an emerging band and message compression system that is able to funnel forty-eight half-hour programs onto a one-hour reel of videotape and play back twenty-four of them simultaneously; and it can relay the programs at high speed over regular television channels. RTS is initally intended to be applied to community college and adult education programs--it also relates to a 1970 Goldmark proposal to foster a decentralized "New Rural Society" based on advanced home com-

munications systems.[81] The potential seems imminent here for routing vast volumes of ordered-up material directly into homes from local cable centers hooked up by satellites into centralized high-speed information libraries. Such capacities would necessitate speedy revision of some of the system-planning and forecasting reported in this paper.[82]

Item: Thomas Ide describes OECA's initial work in formulating "video-skim" searches, a sequence of selected "essential still pictures" taken from a tape to represent its content to a potential user. The system uses a "frame grabber device" (Hughes model 639 Scan Conversion Memory) and a control box to provide this non-print method of indexing.[83] The use of audio descriptors as a substitute for verbal descriptions has also been studied (by E.M. Lewis).[84]

C. Computer and Display Technologies

Computer advances are being made at a rapid rate, but the basic working foundation of scientific and technological research seems already fairly well established. Easily programmed mini-computer peripheral systems able to hook into remote, specialized, large computers are beginning to broaden usage patterns, and cost factors throughout are continuing to improve. The trend toward improved user interfacing that has brought about a 1000X improvement in speed and a 10X improvement in "the value of uniquely human operations/thinking at the computational level" will continue.[85]

Item: Voice response systems for regular conversational interaction with computers (using a data bank of phonetics) is already a commercial reality, with cheaper and more sophisticated equipment becoming available and perhaps eventually supplanting most typed

interaction.

Item: New display devices such as PLATO's flat plasma display panels make interrelating with sophisticated digital three-dimensional motion simulations a reality. Black-and-white and color displays are already being utilized in many high-level special applications.

Item: Computer printers have been designed with rates of 3000 lines per hour of 180 characters per line. Facsimile translators can now achieve rates of 12,000 lines per minute.[87]

Item: Vastly improved color self-scanning cameras utilizing charged-couple (CCD) electronics will soon supplant the still-new silicon-diode camera presently used in the compact Picturephone.

Item: Improvements in freeze-frame technology and holographic storage will soon make them economical. Wall-sized flat TV screens are not yet feasible because of the continuing need for the cathode ray tube, but projection systems are available and advanced display digital conversion techniques hold promise in this realm.[88,89]

II PROJECTIONS FOR IMPLEMENTATION

Louis Vagianos indicates in a state-of-the-art assessment that "a significant backlog has developed between the findings of pure research and their translation into safe and useful products." In addition to technical limits, he describes the economic limits of a finite amount of measured-risk investment capital contended for by all manner of technologies and programs and all underdeveloped areas of the world. This leads, he says, to "piecemeal development and suboptimal performance."

A second economic problem is the considerable problem of copyright, discussed in detail in Nicholas Henry's book on the subject. It took an inordinately long time for a new bill to supplant the 1909 copyright bill because of the continual uncertainties of technological change and the battle between producer and user factions representing large segments of commercial and institutional interests in the U.S. The new bill is an improvement but is still too vague in areas of "fair use" and the newer technologies, and so the situation remains uncomfortable muddled.

Clearly, some new agreements on usage and blanket fee systems must be devised. Hopefully, the newly established federal copyright agency will provide leadership in finding solutions that are equitable to writers and producers, educators, librarians, and computer software designers (who find it difficult to protect their computer programs) and still manage to encourage an innovative, wider use of materials.

Vagianos lists a third limit for system development--the ecological one. Foresight is needed to weigh the pros and cons to decide

whether to scrap present systems (e.g., commutation to colleges) because they pollute, or maintain them because the costs of new systems (e.g., educational CCTV) would tax natural resources, and would thus be less ecologically sound. Interactive home services may be judged to be an economically necessary fuel- and time-saving approach once all the relevant social, ecological, and commercial data have been accumulated and scrutinized. Technological assessments are urgently needed and sorely lacking. It remains for government and industry to promote comprehensive planning and regulatory agencies in order to make the crucial policy decisions about the utilization of technology. Fifty percent of our gross national product is involved in software and hardware related to the information revolution. There is no way we can be confident of success while blindly backing our way into the future.

The chart on the following page is a rough comparison of three projective studies alongside data contained in this report. Considering the state of flux in the field, it would be unwise to view the timetables as other than rough estimates.

FUTURE GROWTH OF NON-PRINT TECHNOLOGY: TIMETABLE OF PROJECTIONS

	1977	1980	1985	1990
COMPUTER-ASSISTED INSTRUCTION	Elementary	Post- Secondary	Secondary	All Schools
Computer-voice replies	Business		Home	
Plug-in Terminals				
Hardware Developments	Microprocessors, IC Chips	Optical Char. Recognition	Comb. IC/ CCD Chips	Super-fast, high-frequency components
Optics	Liquid Crystal, LED	Flat-Panel Plasma Display		Electro-Chroma Display
CABLE TELEVISION	30 Million Homes			100-400 Channels
Interactive Instructional TV	All instructional levels			
Videophone		2-Way, Large-Screen, Color Display.	2 Million Phones, Handwriting & Lightpen Inputs.	Flat Screen, "Fax"
TRANSMISSION		Direct Satellite Data, Fiber Optics	All Digital Lines	Super-high Frequencies / Local Wide-bandwidth
LIBRARY AUTOMATION	Cataloging & Circulation	Full Networking (All types of libraries)	Home Encyclopedia	Orig. Science Data Analysis & Storage
--Hardware		Local Central Catalog Display	Hologram Full Storage	Local On-line Catalogs
--Software		International Non-Print Data Base		
INSTRUCTIONAL R&D CENTERS		3 Regional CAI/ITV/CATV Centers	24-hr. Public Info. Centers	6 Regional Interactive Centers

SOURCES: Bell Canada, 1972[89]; UNESCO Bulletin For Librarians, 1972[89]; IEEE SPECTRUM, 1975[90]; and this paper.

NOTES

1. Delaney, Jack J. The Media Program in the Elementary and Middle School, Its Organization and Administration. Hamden, Conn.: Linnet Books: Shoestring Press, Inc., 1976.

2. Grove, Pearce S. Nonprint Media in Academic Libraries. Chicago: A.L.A., 1975 (ACRL Publications in Librarianship no. 34).

3. American Library Association. Public Library Association Audiovisual Committee. Guidelines for Audiovisual Materials and Services for Public Libraries. Chicago: A.L.A., 1970, rev. 1975.

4. Boyle, Deirdre. "In the Beginning Was the Word...Libraries and Media," Library Journal 101 (January 1976), pp. 125-130.

5. Ide, Thomas R. "Lending Library, Fibre Optics, and Your Living Room," Canadian Library Journal 32 (August 1975), pp. 289-292.

6. Committee for Economic Development. Research and Policy Committee. Broadcasting and Cable Television, Policies for Diversity and Change. New York: CED, 1975.

7. LaComb, Denis J. "Video Technology, Its Future in Libraries," Library Journal 101 (October 1976), pp. 2003-2004.

8. Ide, "Lending Library," pp. 289-292.

9. LaComb, "Lideo Technology," pp. 2003-2004.

10. Seepham, John. "The Open University," in Richard Adler and Walter S. Baer. Aspen Notebook: Cable and Continuing Education. New York: Praeger, 1973 (Praeger Special Studies series), pp. 162-167.

11. Martin-Vegue, Charles Al, Albert J. Morris, et al. "Technical and Economic Factors in University Instructional Television Systems," Proceedings of the IEEE 59 (June 1971), pp. 946-953. Colorado State Research in Graduate Education (SURGE) and at least eleven other systems are described or projected.

12. Vail, Charles R., and Stuart A. Bush. "Talkback TV at Southern Methodist University: Four Years of Experience," Proceedings of the IEEE 59 (June 1971), pp. 954-960.

13. Ledbetter, Theodore S., and Susan C. Greene. "An Overview of Pay Cable Television," Yale Review of Law and Social Action 2 (Spring 1972), pp. 209-215.

14. Molenda, Michael H. "CATV and Access to Knowledge," Yale Review 2 (Spring 1972), pp. 243-251.

15. BM/E Magazine, editors of. "Utilizing Expanded Channel Capacity," in their The CATV Operator's Handbook, 2nd ed. Blue Ridge Summit, Pa.: Tab Books, 1967.

16. Johnson, Nicholas, and Gary G. Gerlach. "The Coming Fight for Cable Access," Yale Review 2 (Spring 1972), pp. 217-225.

17. Ledbetter and Green, "An Overview," pp. 209-215.

18. Buckelow, Dor[illegible]., and W. David Penniman. "The Outlook for Interactive Television," Datamation 20 (August 1974), pp. 54-58.

19. Dorland & Sweeney, Inc. The Wired Public Library (mimeograph) 1973, pp. 28-29.

20. LaComb, "Video Technology," pp. 2003-2004.

21. MITRE Corporation. Urban Cable Systems, Summary. (#M72-57) William F. Mason, Project leader. Washington, D.C.: MITRE, 1972, pp. 31-46.

22. Buckelow and Penniman, "The Outlook," pp. 54-58.

23. BM/E Magazine, editors of. "Utilizing Expanded Channel."

24. Buckelow and Penniman, "The Outlook," pp. 54-58.

25. Henry, Nicholas. Copyright, Information Technology, Public Policy, Pt. 1. New York: Marcel Dekker, 1975, p. 43.

26. "MINITEX," Journal of Academic Librarianship (July 1975), pp. 28-29.

27. Pearson, Carl M. "Dial Access Libraries: Brief Reviews by Telephone," Proceedings of the ASIS 10, pp. 184-185.

28. Billowes, Colin A. "On-Demand Educational Television Program Retrieval System for Schools," Proceedings of the IEEE 59 (June 1971), p. 998.

29. Dickson, Edward, in association with Raymond Bowers. The Video Telephone, Impact of a New Era in Telecommunications. New York: Praeger, 1973.

30. Ibid., p. 193.

31. Ibid., p. 194.

32. Vagianos, Louis. "Today Is Tomorrow: A Look at the Future Information Arena," Library Journal 101 (January 1976), pp. 147-156.

33. Dickson, with Bowers, Video Telephone, p. 43.

34. Costigan, Daniel M. Fax, The Principles and Practice of Facsimile Communication. Philadelphia: Chilton, 1971.

35. Dickson, with Bowers, Video Telephone, pp. 43-44.

36. "BBC Pioneering Experiments in Information Distribution," Wall Street Journal, May 11, 1976, p. 20.

37. Dickson, with Bowers, Video Telephone, pp. 22027, 70-71.

38. Kenney, Brigette, issue ed. "Cable Television for Librarians," Drexel Library Quarterly 9 (January/April 1973), p. 126. Statement by Louis B. Early.

39. LaComb, "Video Technology," pp. 2003-2004.

40. "MINITEX," pp. 28-29.

41. Katz, William A. Introduction to Reference Work: Vol. II, Reference Services and Reference Processes, 2nd ed. New York: McGraw-Hill, 1974, pp. 153-158.

42. Saffady, William. "Microfilm Equipment and Retrieval Systems for Library Picture Collections," Special Libraries 65 (October/November 1974), pp. 440-444.

44. Henry, Copyright, Information Technology, p. 32.

45. Ibid., pp. 31-33.

46. Lanier, Robin. "TV Revolution," New York Times magazine section (1975), pp. 9, 43-46.

47. Katz, Intro. to Reference Work, p. 222. Quotation is taken from Yerkes, Charles P. "Microfilm Information Storage and Retrieval," Information and Records Management (January 1972), p. 29.

48. Slide, Anthony. "The Academy of Motion Picture Arts and Sciences," Films in Review XXVII (May 1976), pp. 289-293, 299.

49. Schaefer, Susan. "A Look at the Future...A TV Library," California School Libraries 47 (Spring 1976), pp. 7-10.

50. Wright, L.C. "Inside Washington: Vanderbilt University Has Been Taping the Nightly News Broadcasts...," College and Research Library News 3 (March 1975), p. 73.

51. Boyle, Deirdre. "Preserving Broadcast History," American Libraries (October 1977), p. 515.

52. Quinn, Christie. "Developments in Film Cataloguing," Audio-visual Librarian 1 (June 1974), pp. 139-144.

53. Boyle, "Preserving Broadcast History, pp. 515-516.

54. Lindberg, Folke. "Gramaphone Records Cataloguing Based on EDP Routines: A Short Survey," Fontes Artis Musicae 21 (June/August 1974), pp. 28-32.

55. Hewlett, R.D. "Instant and Accurate: Organizing the BBC's Information Flow," Aslib Proceedings 26 (June 1974), pp. 215-225.

56. Healey, Gerald B. "News Librarians Rustle Up Electronic Action," Editor and Publisher 108 (June 21, 1975), p. 29.

57. Katz, Intro. to Reference Work, pp. 169-201.

58. Peterson, Gary T. "Networking and Audiovisual Materials," Audiovisual Instruction 20 (March 1975), p. 78.

59. Bogen, Betty. "A Computer-Generated Catalog of Audiovisuals," Bulletin of the Medical Library Association 64 (April 1976), pp. 224-226.

60. Brantz, Malcolm H. "Bibliographic Control for Audiovisuals...," Bulletin of the Medical Library Association 64 (January 1976), pp. 57-60.

61. Lewis, E.M. A Cost Study of Library Color Microimage Storage and Retrieval: Visual Indexing in Microfiche, Super-8, and Videotape. Ph.D. dissertation. CDI 75-07843, 1974.

62. Ide, "Lending Library," p. 290.

63. Ibid.

64. SDC Systems Development Corporation (Brochure). Paramus, N.J.: SDC, 1975.

65. Lockheed Dialog: An On-Line Interactive Retrieval System (Brochure). Palo Alto, Ca.: Lockheed, 1974.

66. DeiRossi, J.A. "Cost Analysis of Minimum Distance TV Networking for Broadcasting Medical Information," RM-6204-NLM. Santa Monica, Ca.: RAND Corp., 1970.

67. Adler and Baer, Aspen Notebook, p. 78.

68. Bruce, Robert R., and John Goberman. "The Electronic Box Office," in Adler, Richard, and Walter S. Baer. The Electronic Box Office; Humanities and Arts on the Cable. New York: Praeger, 1974, pp. 49-77.

69. Adler and Baer, Aspen Notebook, pp. 119-125.

70. Ibid., pp. 42, 77.

71. Ibid., p. 147.

72. Molenda, "CATV and Access," p. 245.

73. Dubin, Robert, and R. Alan Hedley. "The Medium May Be Related to the Message--College Instruction on TV," in Adler and Baer, Aspen Notebook, pp. 137-138.

74. Henry, Copyright, Information Technology, p. 111.

75. Ampex Corporation, Advanced Technology Division. The Pyramid System (Brochure). Sunnyvale, Ca.: Ampex.

76. Bitzer, Donald, and Roger L. Johnson. "PLATO: A Computer-Based System Used in the Engineering of Education," Proceedings of the IEEE 59 (June 1971), pp. 960-968.

77. Henry, Copyright, Information Technology, p. 44.

78. Dickson, with Bowers, Video Telephone, p. 183.

79. Richardson, John M. "Optical Fiber Transmission," The Bulletin of ASIS 2 (January 1976), p. 40.

80. Dickson, with Bowers, Video Telephone, pp. 69-70.

81. Willocks, R. Max. "4 Million Catalog Cards on Seven Little Platters, Library Spin-Offs from Videodisc Technology," American Libraries 6 (December 1975), p. 682.

82. "The Rapid Transmission and Storage Mark I System and the Electronic Publishing Company," (Brochure), Stanford, Conn.: Goldmark.

83. Ide, "Lending Library," pp. 289-292.

84. Lewis, A Cost Study.

85. Neelameghan, A., and S. Seetharama. "Information Transfer: The Next Twenty-Five Years," Librarianship, With a Slant to Documentation 13 (March 1976), pp. 3-14.

86. "Retrieval Voice Response is Marketed by Phonplex," Electronic News (March 15, 1971), p. 54.

87. Vagianos, "Today Is Tomorrow," pp. 147-156.

88. Dickson, with Bowers, Video Telephone, pp. 64-65.

89. Neelameghan and Seetharama, "Information Transfer," pp. 3-14.

90. Vagianos, "Today Is Tomorrow," pp. 147-156.